

MECHANICAL REMOVAL OF NORTHERN  
PIKE FROM THE GUNNISON RIVER,  
1995—1996

Colorado River Recovery Implementation  
Program, Project Number 58

Final Report

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## EXECUTIVE SUMMARY

An important recent initiative of the Recovery Program for the endangered Colorado River fishes has been control of introduced fishes. Introduced species have been implicated in the decline of endangered fishes nation wide because of predation or competition for food or space. A survey of knowledgeable upper-basin biologists identified several species that are believed to have negative effects on the endangered fishes of the upper Colorado River basin; 46% of respondents believed northern pike *Esox lucius* to be an important problem for the native fish community.

Northern pike were stocked into Paonia Reservoir on the North Fork of the Gunnison River in 1969 and 1971. Some fish escaped and established a small population within critical habitat on the Gunnison River near Delta, Colorado. No reproduction has been documented in the Gunnison River and the population apparently relies on continued escapement from Paonia Reservoir to maintain itself. This study was conducted to determine if the population could be substantially reduced through mechanical removal.

Previous work identified a 16-km-long river reach downstream from Hartland Diversion where most northern pike were collected. Sampling efforts targeted that reach. Sampling was concentrated in spring when high water provided quiet, off-channel habitats that were believed to attract northern pike. Workers used electrofishing, fyke nets and trammel nets to intensively sample areas where northern pike had been collected in the past. In contrast with other studies, shoreline electrofishing was the most effective sampling technique for collecting northern pike in the Gunnison River.

A total of ten northern pike were collected and removed from the study area in 1995 and 1996. Six of those pike were captured on the first day of sampling in 1995. Intensive sampling by two-person crews for 27 more days captured three more northern pike. Thirteen days of sampling in 1996 captured one additional northern pike. One pike was observed that could not be captured. The abrupt decline in catch per effort and the sustained low catch rate thereafter indicate that a small population with limited recruitment can be substantially reduced with mechanical means. It is unlikely that all northern pike occupying

the area were captured and removed; however the low catch rate in 1996 suggests that most were.

Based on one year of data, movement of northern pike into the area from the upstream reservoir is slow. However, northern pike will gradually reoccupy critical habitat. Sampling should be repeated regularly (every two to four years) to remove additional pike that occupy the area. Relatively limited sampling at the right time and with the right gear can remove most of the pike. Northern pike use of the study area will be a chronic problem until they are eliminated from Paonia Reservoir—the apparent source of all pike in the Gunnison River.

## INTRODUCTION

An important recent initiative of the Recovery Program for the endangered Colorado River fishes has been control of introduced fishes. Introduced species have been implicated in the decline of endangered fishes nation wide because of predation or competition for food or space (e.g. Ono et al. 1983; Courtenay and Kohler 1986). A survey of knowledgeable upper-basin biologists by Hawkins and Nesler (1991) identified several species that are believed to have negative effects on the endangered fishes of the upper Colorado River basin; 46% of their respondents believed northern pike *Esox lucius* to be an important problem for the native fish community.

Northern pike have been stocked in several upper basin lakes or reservoirs and have escaped to the mainstem rivers of the basin. In the Yampa River drainage, pike were stocked into Elkhead Reservoir on Elkhead Creek, a tributary to the Yampa. The species escaped from the reservoir and established a self-sustaining population in the mainstem Yampa River and associated floodplain ponds and sloughs (Nesler 1995). Northern pike increased dramatically in abundance in the Yampa River from early escapement to the present. Miller et al. (1982) captured seven northern pike during an intensive river-wide, year-around sampling effort in 1981, but recent efforts by the Interagency Standardized Monitoring Program have captured as many as 70 in week-long, shoreline electrofishing samples (McAda et al. 1994). These collections were downstream from the major population center for the species which is upstream from Craig, CO (Nesler 1995). The population is large enough to attract considerable interest from sport fishermen. Individuals from this population have moved downstream into the Green River where important habitat for young-of-year Colorado squawfish *Ptychocheilus lucius* occurs (Tyus and Beard 1990; McAda et al. 1994). Predation on small Colorado squawfish has been documented there (Crowl and Lentsch 1996).

Northern pike are considerably less abundant in the Colorado River subbasin. Northern pike have occasionally been captured in scattered locations in the river system (e.g. Valdez et al. 1982a, b; McAda et al. 1994; USFWS, unpublished data), but occur in notable numbers only in the Gunnison River near Delta, CO (Burdick 1995). Burdick captured 20 northern

pike during an intensive 2-year study of the Gunnison River between its confluence with the North Fork and its confluence with the Colorado River. All but two of those fish were captured in the floodplain area near Delta. The other two were captured downstream from Redlands Diversion Dam located about 3.7 km upstream from its mouth. These fish apparently escaped from Paonia Reservoir, a small irrigation reservoir on the North Fork of the Gunnison River. The Colorado Division of Wildlife stocked the reservoir in 1969 and 1971, but no longer manages the reservoir as a northern pike fishery (Sherman Hebein, Colorado Division of Wildlife, personal communication).

All of the fish captured by Burdick (1995) were subadults or adults—there was no evidence of successful reproduction in the Gunnison River during his 2-year study. The population is small and is probably composed of individuals that have survived in the river since their escape from the upstream reservoir. Because of the small number of fish found in the Gunnison River, the habitat conditions there are apparently not as conducive to reproduction and survival of northern pike as is the Yampa River.

The Gunnison River still supports a few Colorado squawfish, but wild razorback sucker *Xyrauchen texanus* have been eliminated from the river (Burdick 1995). However, the Gunnison River is an important recovery site for both of these species and hatchery-reared razorback suckers have already been stocked into the river (Burdick and Bonar 1997). Further, the Recovery Program is initiating a program to restore flooded bottomland habitat throughout the upper basin. Some of this habitat restoration will occur in the Gunnison River basin. Increasing the amount of floodplain habitat in the Gunnison River might allow the small northern pike population to reproduce, at least in some years.

To prevent occupation of the expanded quiet-water habitat by northern pike, and to reduce predation on stocked endangered fish, the Recovery Program initiated a study to determine if the northern pike population in the Gunnison River could be substantially reduced by mechanical means. This report documents that effort.

## STUDY GOAL AND OBJECTIVES

Goal: Prevent colonization of restored flooded-bottomland habitats by introduced predators, especially northern pike.

- Objectives:
1. Evaluate standard techniques for efficient removal of nonnative predators.
  2. Estimate relative decline in nonnative predators as a result of fish removal.
  3. Determine short-term reinfiltration rates of nonnative predators back into important habitats.

## METHODS

Burdick (1995) identified locations and time periods when nonnative predators were concentrated. As noted above, all but two of the northern pike collected by Burdick were between river kilometer (RK; distance upstream from confluence with Colorado River) 86.7 and 117.8. Further, 13 of those 18 fish were collected in a 2.9-km-long reach immediately below Hartland Diversion (RK 96.4). Two of the remaining pike were captured in a flooded area at RK 86.7 and three were captured upstream from Hartland Diversion. For this study, sampling efforts were concentrated in a 16-km-long reach downstream from Hartland Diversion (Figure 1) where Burdick (1995) captured 15 northern pike. Three different sampling gears (electrofishing, trammel nets, and fyke nets) were used to collect fish during the 2-year study. Electrofishing was used in shoreline habitats when water conditions were suitable. Water level was generally too low to shock effectively during summer and too high for safe sampling during peak runoff. Quiet-water habitats were sampled with trammel nets and fyke nets. Trammel nets were usually used as part of the 'scare and snare' technique (blocking the mouth of a backwater and driving fish into the net by creating a disturbance in the backwater; *sensu* Osmundson and Burnham 1996), but were also used in stationary sets for one or two hours at a time. Fyke nets were used in overnight sets in flooded areas out of the main current where northern pike might be expected to congregate. They were set in a variety of quiet, flooded-vegetation habitats including an old oxbow where Burdick (1995)



FIGURE 1.—Gunnison River study area.

captured two northern pike during his study. The river above Hartland Diversion was not sampled. Although relatively few northern pike were captured there by Burdick (1995), that reach was not sampled in this study to provide a source of undisturbed fish to determine how quickly northern pike would repopulate the study reach.

Most sampling was done in spring (April-early June) when high water provided quiet, off-channel habitats that were believed to attract northern pike. Sampling was done occasionally in summer (July) and then more intensively in fall (September-early November). Sampling was accomplished by two- (occasionally three-) person crews using the technique deemed most appropriate for the time and location. Occasionally two crews worked together using either one electrofishing boat and a netting crew or two electrofishing boats sampling

both sides of the river. Sampling crews worked the river at least two days a week during intensive sampling in the spring. When electrofishing, all northern pike and other predators were captured during all samples. Other species were captured and counted in about one-half of the electrofishing efforts. Only northern pike or other predators were counted during trammel netting, but all species were identified and counted when fyke nets were used. All fish collected and identified in selected electrofishing collections were measured for total length (TL,  $\pm 1$  cm) before release. All captured northern pike were measured (TL,  $\pm 1$  cm) and removed from the river. In 1995, northern pike were held alive, picked up by the Colorado Division of Wildlife, and transported to Harvey Gap Reservoir. In 1996, all pike were humanely sacrificed, gutted, frozen, and given to the Division for distribution to local food banks.

Date and location were recorded for each sampling effort. Sampling effort was recorded for all fyke net samples (total hours the net was set) and for about one-half of all electrofishing samples (seconds of shocking time). However, beginning and ending point (river kilometer) were recorded for all electrofishing collections. Sample effort was not recorded for trammel net collections. Mean catch per effort (CPUE) was calculated for all fyke net and electrofishing samples. Electrofishing CPUE for northern pike was calculated using kilometers of shoreline electrofished since that measurement was recorded for all electrofishing collections. Mean CPUE for other species was calculated using seconds (converted to hours) of shocking time for samples when all fish observed were collected and counted. Mean CPUE for fyke net samples was calculated using hours that the net was set. Length-frequency distributions for northern pike and common sympatric species were also calculated.

Because of the variety of gears used during different time periods, catch per effort was also calculated using 'crew-days' as a gross comparison among different gears, seasons, and years. One crew-day equaled effort expended by a two- or three-person crew during at least part of one day. In most cases, full days of sampling were expended by each crew (8-hr day, including 2 hr travel time). Crews usually used a single gear type for the whole day. However, occasionally two different gears were used (e.g. electrofishing after the fyke nets

were checked for the day). Effort was considered to be one crew-day, even though two or more gears were used. Fyke nets were sometimes fished for several days without being checked, but crew-days included only the days when the nets were set or checked (e.g. several fyke nets set for three days and two nights were counted as two crew days).

## RESULTS

Within the 16-km study area, nine northern pike were captured and removed in 1995 and one was captured and removed in 1996 (Figure 2). A total of 28 crew-days were expended in 1995 and 13 crew days were expended in 1996. Only one northern pike was observed but not captured. One additional northern pike was removed from the Gunnison River in 1996 during other sampling activities. It was captured in the fishway around the Redlands Diversion Dam. This fish was not included in catch-per-effort calculations, but it was included in distribution and length-frequency analyses.

In 1995, sampling success was immediate and dropped off dramatically (Figures 2 and 3). Six northern pike were captured on the first day of sampling—four of those fish were caught in a single 1.1-km-long electrofishing pass immediately below Hartland Diversion. The other two pike were captured in the remaining 4.7 km downstream to Confluence Park. Surprisingly, a second crew doing 'scare and snare' in flooded areas ahead of the electrofishing boat failed to capture any northern pike, even though many of the backwaters sampled by the netting crew were also shocked after the mouth was blocked. No northern pike were captured on the second day of electrofishing—even though electrofishing effort was doubled over day one—and one pike was collected on the third day of electrofishing. No additional pike were collected until early fall even though considerable effort was expended. In addition to electrofishing, fyke nets and trammel nets were set in flooded areas throughout the runoff period. Two or more fyke nets were set for at least two nights each week during runoff. A flooded area at RK 36.7 where Burdick (1995) captured two northern pike was regularly sampled. However, the intensive effort failed to capture any additional pike. The two fish caught in September were captured by trammel netting backwaters along the river

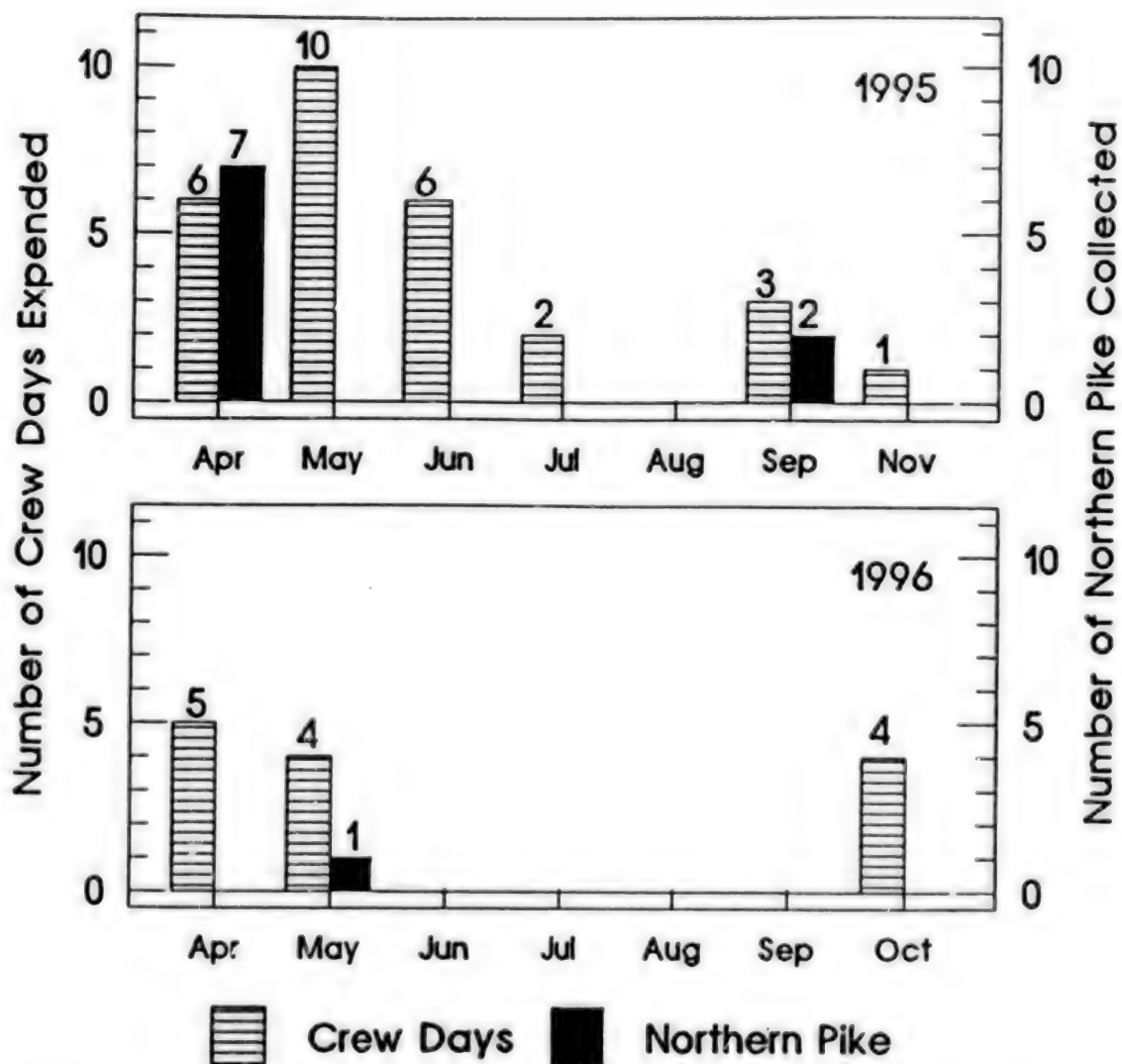


FIGURE 2.—Total number of northern pike collected and total number of days that sampling crews spent in the field. One crew day represents the efforts of one sampling crew for one day. Sampling gears included electrofishing, fyke nets and trammel nets.

near Hartland. More electrofishing in early November failed to catch any additional northern pike.

Only one northern pike was collected within the study area in 1996. In contrast with 1995, several days of electrofishing had been conducted prior to it's capture. An important contributing factor to successfully capturing pike with electrofishing was river flow. When sampling began in 1995, the water was high enough that shallow, weedy areas along the shoreline were flooded. These flooded shoreline habitats contained most of the northern pike

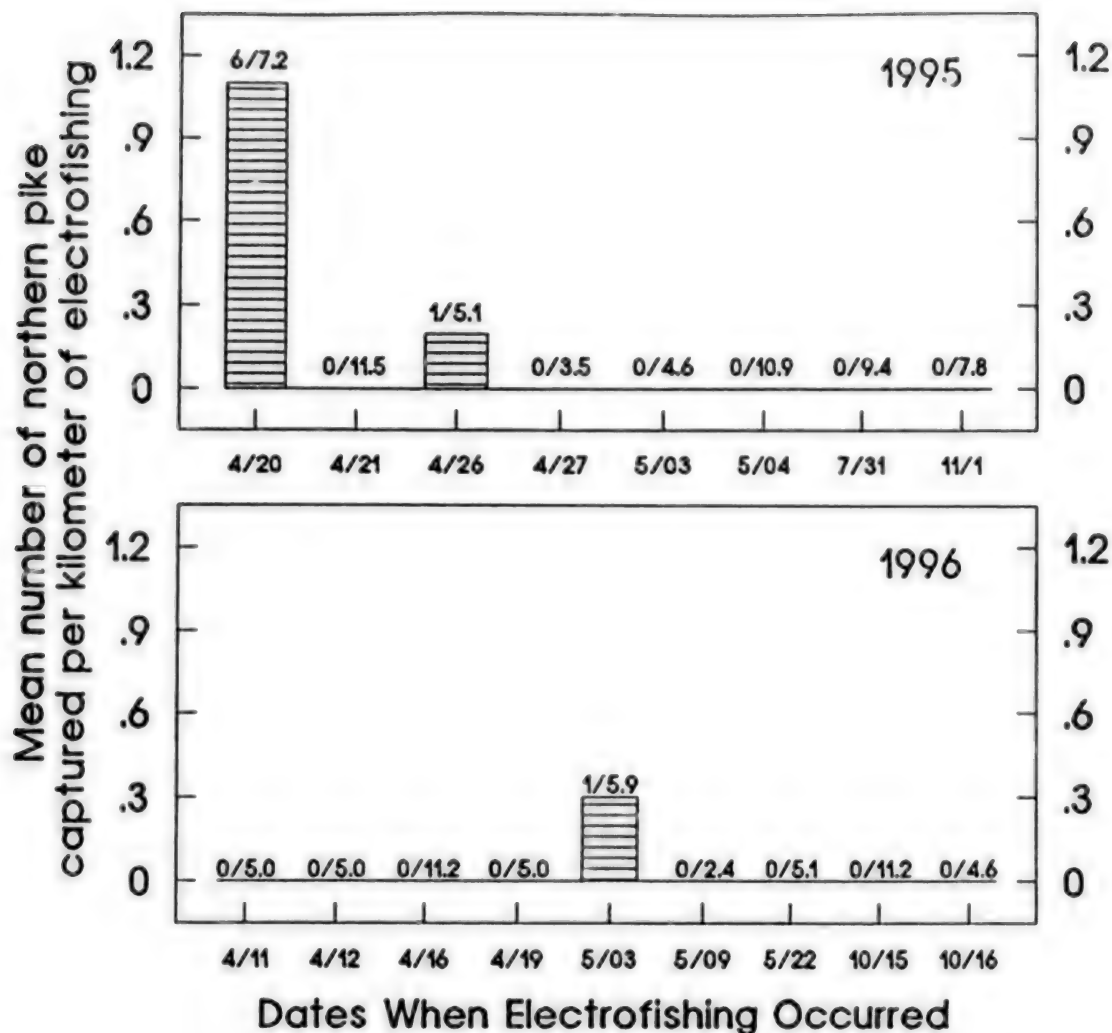


FIGURE 3.—Mean number of northern pike collected per kilometer of shoreline electrofishing. Electrofishing was done on eight days in 1995 and nine days in 1996. Numbers represent total number of northern pike collected/total kilometers of shoreline electrofished.

collected in this study. Sampling in 1996 began when water levels were lower and the weedy areas were not yet flooded. The single northern pike was captured after river flows increased to about 113 m<sup>3</sup>/s and flooded the shoreline vegetation. However, continued sampling during the same conditions did not capture any additional fish. As in 1995, sampling of flooded habitats during runoff with trammel nets and fyke nets did not capture any northern pike. Spring runoff was less in 1996 than it was in 1995, so the flooded habitats were not available for sampling for as long a period.

One northern pike was observed in a small, relatively shallow backwater during 'scare and snare.' The fish surfaced in front of the net immediately after the mouth was blocked. The fish had apparently detected the net and avoided moving into it. Considerable time was spent covering the backwater and trying to drive the fish into the net. Two investigators started at the upper end and drove toward the net causing considerable commotion and thrashing through the available vegetation. Two complete drives were made through the backwater, but the pike was not captured even though the mouth was completely blocked. Apparently it was able to avoid the people in the backwater and not be driven into the net. No electrofishing boat was available on that day to shock the backwater.

The smallest northern pike captured was 35 cm long and the largest was 86 cm long. Most of the fish were between 50 and 75 cm long (Figure 4). This size structure was very similar to that observed by Burdick (1995). Burdick PIT tagged seven of the 15 fish that he collected within the 95–96 study area. Only two tagged fish were recaptured during this study. All pike collected in this study were captured from the same areas as Burdick (1995; Figure 5) except that none were captured above Hartland Diversion because it was not sampled. As mentioned above, Burdick collected 13 pike in a 3.1-km-long reach below Hartland Diversion. Ten of those fish were caught in or near a large backwater at RK 86.7. Most of the fish captured in this study were also collected near that backwater.

Other species captured during this study included bluehead sucker *Catostomus discobolus*, flannelmouth sucker *C. latipinnis*, roundtail chub *Gila robusta*, brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss*, common carp *Cyprinus carpio*, black bullhead *Ameiurus melas*, green sunfish *Lepomis cyanellus*, white sucker *C. commersoni*, and hybrids between white sucker and bluehead and flannelmouth suckers (Tables A-1 and A-2). The introduced white sucker was the most common species captured in both electrofishing and fyke net collections. The two salmonid species were most common in electrofishing collections immediately below Hartland Diversion and were rarely collected in the flood plain. Green sunfish and black bullhead were exclusively collected from floodplain habitats—they were not captured in mainstem electrofishing collections. All green sunfish and black bullhead encountered were humanely sacrificed and removed from the river. The

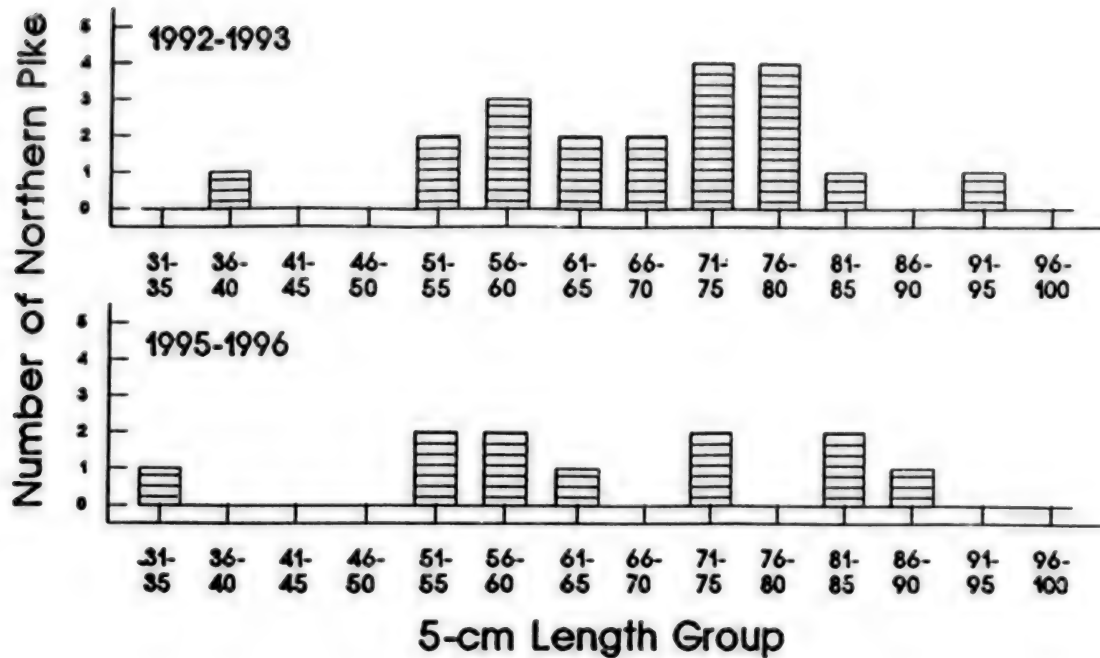


FIGURE 4.—Length-frequency distribution of northern pike collected from the Gunnison River in 1992-1993 (Burdick 1995) and 1995-1996.

remaining species were collected from both habitat types. No largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieu*, or other introduced predators except for those already mentioned were captured. Length frequency distributions for the most common species were similar to earlier collections (Table A-3).

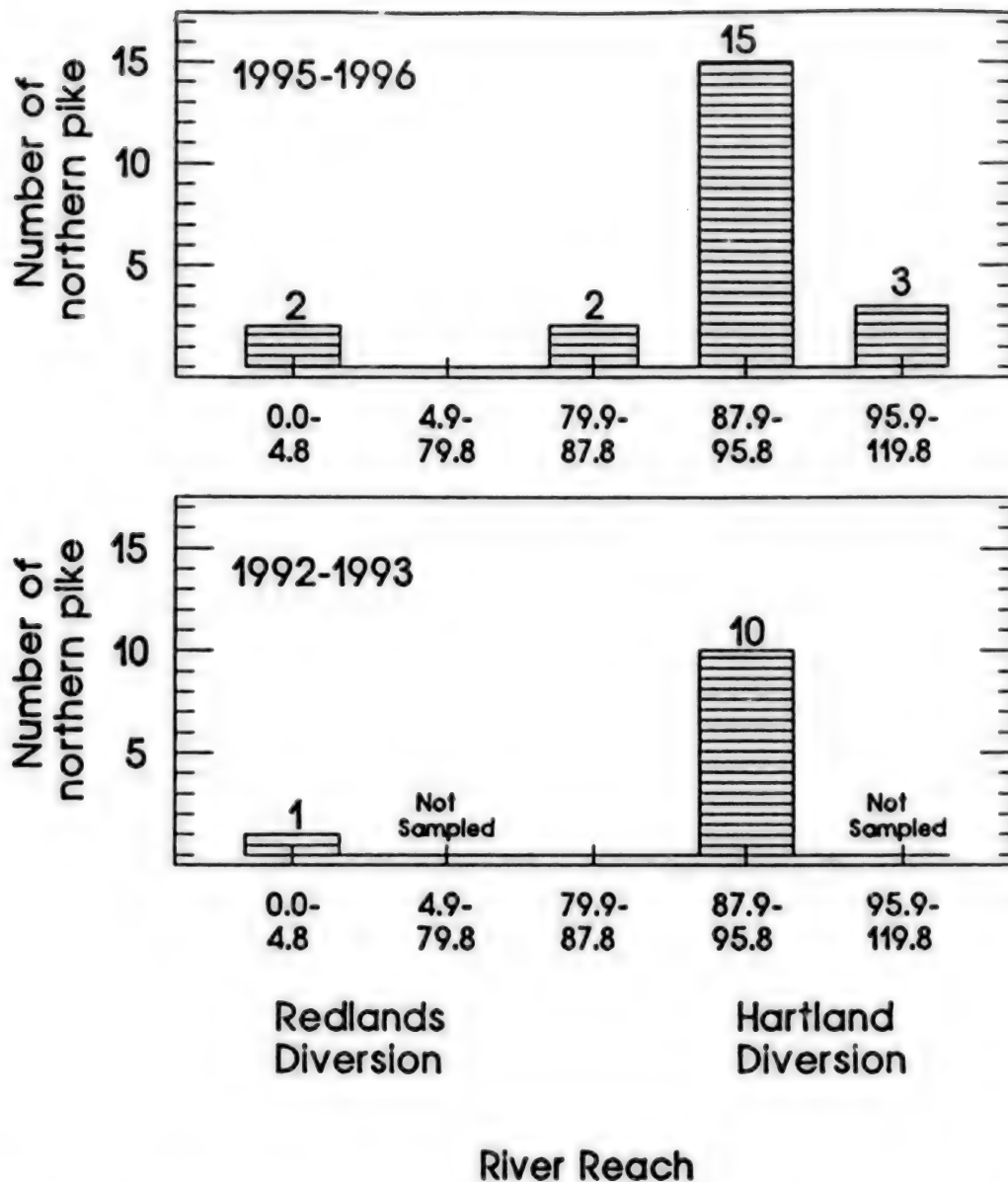


FIGURE 5.—Capture location of northern pike collected from the Gunnison River in 1992–1993 (Burdick 1995) and 1995–1996.

## DISCUSSION

The sharp decline in electrofishing success after one day of sampling indicates that it is possible to substantially reduce the Gunnison River northern pike population through mechanical means—at least temporarily. Further, if timed correctly, most of the reduction will take place quickly and with relatively little effort. Based on the sustained low catch rate, relatively little, if any, movement into the study area by northern pike occurred over the 2-year study. However, it is impossible to determine whether the lone pike captured in 1996 was missed in 1995 or was a recent migrant. Although the population was reduced, it is very likely that more fish will move back into the study area over time.

Shoreline electrofishing was the most effective technique for capturing northern pike. Six of the 10 fish captured within the study area during 2 years of effort were collected on the first day of sampling. Netting of backwaters using still sets or 'scare and snare' was relatively ineffective—only two fish were collected with trammel nets. This is quite different than observed by Nesler (1995) who captured most of the northern pike he handled by blocking backwaters with trammel nets and driving fish into the net with electrofishing. No northern pike were collected with fyke nets either, even though they were the gear used for the greatest amount of time. Fyke nets were set in a variety of quiet, flooded-vegetation habitats including an old oxbow where Burdick (1995) captured two northern pike during his study. This lack of success was surprising since this quiet-water habitat should have been heavily used by northern pike based on experience in the Yampa River (Nesler 1995). However, the failure to capture pike in the sloughs of the Gunnison River gives further credence to the conclusion that the small population can be quickly reduced with mechanical means.

Burdick (1995) captured 15 northern pike within the study area with 12 days of effort in 1992 and 15 days of effort in 1993. All pike that he captured were released alive and seven of those fish were PIT tagged before release. Two PIT tagged fish were recaptured in this study. Catch per effort for northern pike was lower in 1995–1996 than it was in 1992–1993 and five of seven tagged fish released by Burdick were not recaptured. It is unknown

whether the other tagged fish had left the area, died or somehow evaded capture. It is possible that fish do not establish permanent residence in the area, and continue moving downstream after a short time. This downstream movement could account for the difference in catch rate observed in the two studies. However, one tagged pike remained in the area for 2 years and the other remained there for 3 years before they were removed from the river.

Another possible explanation could be removal of northern pike by anglers. Before beginning this study, local anglers were notified that northern pike were going to be removed from the river. Much of the limited angling that occurred prior to the notification had been catch and release. However, after hearing about this project, some anglers indicated that they would remove northern pike themselves rather than return them to the river as they had done in the past (B. Burdick, USFWS, personal communication). It is possible that they caught and removed some pike before the study began. However, it is impossible to determine how many northern pike may have been caught and kept by local anglers.

It is also possible that the lack of recaptures and the immediate decrease in electrofishing success was because pike that were not captured learned to avoid the electrofishing boat. However, no pike were observed when electrofishing that could not be captured, and the lack of northern pike in off-channel habitats suggests that the decline in pike numbers was real. Based on high use of sloughs and other flooded-vegetation habitats in the Yampa River, it seems unlikely that pike would have remained in the main channel, away from quiet-water habitats during runoff.

The low catch rate in 1996 also suggested that pike did not rapidly recolonize the study area from upstream. However, it is difficult to draw conclusions about reinfiltration rates based on 1 year of data. The source of new pike is small so removal efforts should remain effective for several years at a time. However, removal will have to be a regular activity until northern pike have been eliminated from Paonia Reservoir.

Nesler (1995) removed northern pike from parts of the Yampa River from 1989–1992. His study area was similar to the Gunnison River in that reproduction occurred upstream and recruitment to the population came from the upstream reach. However, the Yampa population was considerably larger than found in the Gunnison River and reproduction

occurred in the Yampa River rather than an upstream reservoir. Nesler (1995) removed northern pike from backwaters in the Juniper, Maybell, and Lily Park reaches and reported a general decrease in catch rates for the three sites during the 4-year study. He concluded that it would be possible to reduce the northern pike population in the Yampa River by mechanical removal.

Tyus and Beard (1990) removed 58 northern pike from the Green River over a 5-year period to investigate food habits. They reported a gradual increase in numbers collected during the study period, but effort may have varied from year to year. The Interagency Standardized Monitoring Program (ISMP) reported a decrease in pike numbers in the same area during 3 years when the two studies overlapped (McAda et al. 1994). It is not clear why there are discrepancies in the two data sets, but the decrease in ISMP catch rates may simply reflect the removal efforts of Tyus and Beard (1990). As in the Gunnison and lower Yampa rivers, northern pike do not reproduce in this reach of the Green River and recruitment is from subadults and adults moving into the area.

Lentsch et al. (1996) reviewed the literature to evaluate options for selective control of nonnative fishes in the Upper Colorado River Basin. They felt that it was possible to reduce northern pike abundance in the upper basin by targeting areas where they are common or congregate for spawning. However, in habitats where successful reproduction occurs, attempts to reduce northern pike populations by mechanical means have been relatively unsuccessful (reviewed by Nesler 1995).

The Gunnison River is historic habitat for razorback sucker, but no wild fish have been collected there since the mid 1980's (Burdick 1995). However, it is listed as Critical Habitat for the species (USFWS 1994) and preliminary attempts to reintroduce razorback sucker to the Gunnison River have begun. About 300 7-15-cm-long fish were stocked in fall, 1995 and about 300 30-40-cm-long fish were stocked in fall, 1996 (Burdick and Bonar 1997). Stocking rates are expected to increase in the future. These fish were stocked in backwaters and other quiet water habitats near Delta—the same habitats occupied by the northern pike before their removal. Based on northern pike gape data presented by Nesler (1995), razorback suckers in the first stocking would have been vulnerable to predation by all but the

smallest northern pike removed from the Gunnison River. However, many razorbacks in the second stocking were large enough to escape predation by all but the largest of the northern pike collected.

Heavy predation on newly stocked razorback suckers by channel catfish *Ictalurus punctatus* and flathead catfish *Pylodictis olivaris* was considered to be the most important reason for their poor survival in the Gila River, Arizona (Marsh and Brooks 1989). In the upper basin, Osmundson (1987) reported heavy predation on age-1 Colorado squawfish stocked into gravel-pit ponds containing largemouth bass. Based on the results of those two studies, reducing the predator load in the Gunnison River should increase the survival of newly stocked razorback suckers. This is especially true for a species like northern pike which occupies the same habitats that young razorback suckers would be expected to use.

The Gunnison River contains a small number of adult Colorado squawfish. Radiotelemetry indicated movement as far upstream as Hartland Diversion, but their center of distribution is 20 to 30 km downstream (Burdick 1995). All of the adult Colorado squawfish captured to date from the Gunnison would probably evade predation by northern pike because of their large size. However, large numbers of northern pike in the Gunnison might be able to limit recruitment of subadult fish that move upstream through the newly-constructed Redlands fishway. Nesler (1995) felt that limiting recruitment of subadult Colorado squawfish to the Yampa River population might be the biggest impact to the species there. He also felt that roundtail chub populations could be negatively affected by northern pike since chubs appear to be a preferred food item. The Gunnison River near Delta contains a healthy roundtail chub population (Burdick 1995) that could be reduced if northern pike are allowed to increase because of floodplain restoration or other management activity.

The large white sucker population in the Gunnison River could also pose a threat to razorback suckers as well as to the still common flannelmouth sucker and bluehead sucker. There is a high incidence of hybridization between white sucker and the two native suckers in the Gunnison River. Their abundance could lead to hybridization with razorbacks when stocked fish mature and begin reproducing. Their high abundance in floodplain habitats and

in the main channel could also provide competition for young razorbacks learning to survive in the riverine environment. White suckers should be removed from the Gunnison River when encountered during routine sampling.

## CONCLUSIONS

### Objective 1: Evaluate standard techniques for efficient removal of nonnative predators.

Shoreline electrofishing was effective at capturing northern pike for removal from the Gunnison River near Delta. Because of lack of reproduction and its small size, the northern pike population in the Gunnison River can be controlled with mechanical means. The population occupies a small area that can be effectively sampled with relatively little effort. Limited sampling can capture enough pike to substantially depress the population if efforts are directed at time periods when northern pike are most vulnerable. Based on this study, shoreline electrofishing when river flows are between 85–113 m<sup>3</sup>/s will be the most effective sampling technique.

Green sunfish and black bullhead were the only other predators collected during this study. Because these species are common in the Gunnison River and are actively reproducing in the Delta area, controlling their populations will be considerably more difficult than northern pike. Although sampling with traditional methods (e.g. electrofishing, trammel and fyke nets, seining) can remove large numbers of these species, their populations will quickly rebound because of their high reproductive potential. Control of these species will require use of piscicides or water level manipulation in floodplain habitats where they are most common. Control of these (and similar) species is currently being addressed by the pond reclamation program already funded by the Recovery Program.

### Objective 2. Estimate relative decline in nonnative predators as a result of fish removal.

Based on change in catch rate (both electrofishing alone and all gears combined), numbers of northern pike declined notably in the Gunnison River in 1995 and remained low

in 1996. No population estimates are available, but the data suggest that the decline was real and not a result of sampling inefficiencies or learned behavior on the part of northern pike. Decline in the green sunfish and black bullhead populations was not measured. However, it is unlikely that their populations declined at all. Their removal was incidental to the primary purpose of the study, which was to remove northern pike.

Objective 3. Determine short-term reinfiltration rates of nonnative predators back into important habitats.

Based on a very low catch rate in 1996, the reinfiltration rate of northern pike into the area is low. It is impossible to tell whether the one pike captured in 1996 was new to the area or was missed in 1995. However, it is difficult to believe that all fish in the area were removed in 1995. Nonetheless, the sustained low catch rate in 1996 indicates that large numbers of 'new' fish did not move into the study area from upstream.

Although the reinfiltration rate is low, northern pike will gradually move back into critical habitat from the North Fork of the Gunnison River and Paonia Reservoir, and removal will have to be repeated. However, regular sampling should depress the population enough to substantially reduce the predation threat on hatchery-reared razorback suckers and the rest of the native fish community. Additional northern pike should be removed when encountered during regular monitoring for stocked razorback suckers or during other sampling efforts in other parts of the Gunnison and Colorado rivers.

The only way to completely remove northern pike from Critical Habitat will be to eliminate them from Paonia Reservoir, the source of all pike in the Gunnison River. Eradication of the species will require a considerable commitment of time and resources, but ultimately will be necessary if pike removal from critical habitat is to be anything but a regular activity.

## RECOMMENDATIONS

- Northern pike should be removed from the Gunnison River downstream from Hartland Diversion on a regular basis (intervals of 2-4 years). Sampling to remove pike should be timed to correspond with river flows of 85-113 m<sup>3</sup>/s to be most effective. One week of effort at the right time should be enough to remove most of the pike occupying the reach. This specific effort may not be necessary if northern pike are removed from this reach during other studies.
- Northern pike and other predators should be removed from the system when encountered during routine sampling operations throughout the Gunnison and Colorado rivers.
- The Colorado Division of Wildlife (in accordance with the Non-Native Stocking Procedures) should develop a Fishery Management Plan for Paonia Reservoir that includes an option to eradicate northern pike from the Reservoir. Funding and timing should be evaluated according to the overall priorities of the Recovery Program.
- White suckers should be removed from the Gunnison River when encountered during routine sampling operations.

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## APPENDIX A

TABLE A-1.—Total number collected and mean catch per hour of electrofishing for non-target fishes in electrofishing samples where all fish observed were captured and counted, 1996.

| Species             | Spring (n=12)   |                  |                    | Fall (n=3)      |                  |                    |
|---------------------|-----------------|------------------|--------------------|-----------------|------------------|--------------------|
|                     | Total Collected | Percent of Total | Mean CPE (Fish/Hr) | Total Collected | Percent of Total | Mean CPE (Fish/Hr) |
| Bluehead Sucker     | 41              | 6.5              | 10.38              | 39              | 22.4             | 79.76              |
| Flannemouth Sucker  | 98              | 15.4             | 25.68              | 49              | 28.2             | 149.24             |
| Roundtail Chub      | 78              | 12.3             | 19.70              | 4               | 2.3              | 13.33              |
| Brown Trout         | 100             | 15.7             | 26.57              | 33              | 19.0             | 82.90              |
| Rainbow Trout       | 13              | 2.0              | 3.29               | 5               | 2.9              | 9.70               |
| Common Carp         | 90              | 14.2             | 22.66              | 7               | 4.0              | 7.78               |
| Green Sunfish       | 0               | 0                | -                  | 1               | 0.6              | 1.11               |
| White Sucker        | 209             | 32.9             | 17.42              | 35              | 20.1             | 69.08              |
| White x Bluehead    | 3               | 0.5              | 0.70               | 0               | 0                | -                  |
| White x Flannemouth | 3               | 0.5              | 0.72               | 1               | 0.6              | 0.81               |

TABLE A-2.—Total number collected and mean catch per day of sampling for non-target fishes in fyke-net samples where all fish captured were identified and counted.

| Species              | 1995 (n=8; 16 days total) |                  |                     | 1996 (n=4; 6 days total) |                  |                     |
|----------------------|---------------------------|------------------|---------------------|--------------------------|------------------|---------------------|
|                      | Total Collected           | Percent of Total | Mean CPE (Fish/Day) | Total Collected          | Percent of total | Mean CPE (Fish/Day) |
| Bluehead Sucker      | 124                       | 12.7             | 7.75                | 15                       | 5.1              | 2.19                |
| Flannelmouth Sucker  | 122                       | 12.5             | 7.60                | 25                       | 8.5              | 4.11                |
| Roundtail Chub       | 201                       | 20.6             | 12.56               | 70                       | 23.8             | 12.95               |
| Brown Trout          | 5                         | 0.5              | 0.30                | 7                        | 2.4              | 1.03                |
| Rainbow Trout        | 1                         | 0.1              | 0.06                | 1                        | 0.3              | 0.26                |
| Common Carp          | 48                        | 4.9              | 3.00                | 9                        | 3.1              | 1.67                |
| Black Bullhead       | 25                        | 2.6              | 1.56                | 4                        | 1.4              | 0.90                |
| Green Sunfish        | 25                        | 2.6              | 1.56                | 1                        | 0.3              | 0.13                |
| White Sucker         | 422                       | 43.2             | 26.40               | 157                      | 53.4             | 27.58               |
| White x Bluehead     | 1                         | 0.1              | 0.06                | 0                        | 0                |                     |
| White x Flannelmouth | 2                         | 0.2              | 0.13                | 5                        | 1.7              | 0.90                |

TABLE A-3.—Length-frequency distribution for the most common species collected in selected electrofishing samples, Gunnison River, 1996.

| Four-cm<br>Length<br>Group | Bluehead<br>Sucker | Flannemouth<br>Sucker | White<br>Sucker | Roundtail<br>Chub | Rainbow<br>Trout | Brown<br>Trout |
|----------------------------|--------------------|-----------------------|-----------------|-------------------|------------------|----------------|
| 9-12                       |                    | 4<br>(2.9%)           | 1<br>(0.4%)     | 1<br>(1.2%)       |                  |                |
| 13-16                      | 1<br>(1.3%)        | 2<br>(1.4%)           | 6<br>(2.5%)     | 4<br>(4.8%)       |                  | 3<br>(2.6%)    |
| 17-20                      |                    | 7<br>(5.0%)           | 7<br>(3.0%)     | 2<br>(2.4%)       |                  | 4<br>(3.4%)    |
| 21-24                      | 1<br>(1.3%)        | 2<br>(1.4%)           | 17<br>(7.2%)    | 10<br>(12.0%)     |                  | 20<br>(17.2%)  |
| 25-28                      | 6<br>(7.8%)        | 1<br>(0.7%)           | 23<br>(9.7%)    | 23<br>(27.7%)     | 2<br>(12.5%)     | 43<br>(37.1%)  |
| 29-32                      | 5<br>(6.5%)        | 2<br>(1.4%)           | 30<br>(12.6%)   | 23<br>(27.7%)     | 3<br>(18.8%)     | 18<br>(15.5%)  |
| 33-36                      | 21<br>(27.3%)      | 13<br>(9.4%)          | 68<br>(28.7%)   | 10<br>(12.0%)     | 7<br>(43.8%)     | 22<br>(19.0%)  |
| 37-40                      | 38<br>(49.4%)      | 12<br>(8.6%)          | 53<br>(22.4%)   | 6<br>(7.2%)       | 4<br>(25.0%)     | 5<br>(4.3%)    |
| 41-44                      | 5<br>(6.5%)        | 38<br>(27.3%)         | 29<br>(12.2%)   | 4<br>(4.8%)       |                  | 1<br>(0.9%)    |
| 45-48                      |                    | 41<br>(29.5%)         | 3<br>(1.3%)     |                   |                  |                |
| 49-52                      |                    | 11<br>(7.9%)          |                 |                   |                  |                |
| 53-56                      |                    | 6<br>(4.3%)           |                 |                   |                  |                |
| Total                      | 77                 | 139                   | 237             | 83                | 16               | 116            |



**END**

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